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Bosque Ecosystem Monitoring Program
Final Programmatic Report for Urban Waters Montoring
2014-2016

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Bosque Ecosystem Monitoring Program (BEMP)

Introduction

Water within the Rio Grande supports hundreds of miles of riparian forest, abundant and diverse fauna, and thousands of individuals throughout the watershed. Anthropogenic influences can and have led to highly impacted river systems, particularly through dense urban areas. With support from the U.S. Environmental Protection Agency (EPA) Urban Waters program, the Bosque Ecosystem Monitoring Program (BEMP) has sampled the Rio Grande itself along with nearby irrigation ditches and groundwater to better understand quality of this precious resource. Sampling took place three times per year (spring, summer, and fall), at seven locations (plus two to four match sites) along 137 km of the river from Bernalillo to San Acacia, NM. Sample locations were selected with the intent to investigate changes in quality as the water flows downstream. BEMP involved university and 6-12th grade students in the water quality monitoring and helped students to analyze and present the data they collected to their communities. This provided the students with both hands-on experiential learning and opportunities to invest in building collaborations within the community.

Program Accomplishments

Section 1. Comparison of actual accomplishments with anticipated outputs/outcomes (information also available in Table 1 in chronological order with project milestones).

Outputs

In the following section, predicted outputs are in blue text, actual accomplishments are in black text.

1) There will be three extensive water sampling events at thirteen sites each year. Students will be directly involved in data collection. There were six extensive water sampling events over two years of the grant. Students were directly involved in data collections. Sampling was done at 9 to 11 sites (7 EPA funded sites and between two to four match sites). In addition, two sites that were outside the designated boundaries of the EPA Urban Waters Middle Rio Grande reach were also monitored, though as they are outside the parameters of this grant, those data and outreach numbers are not included in this report.

2) There will be two water sampling events at four sites each year to monitor pharmaceuticals and personal care products (PPCPs), indicators of wastewater treatment. There were a total of four PPCP sampling events at four sites as anticipated.

3) All data will be non-proprietary and housed on multiple websites for increased accessibility to the public, irrigators, resource managers, or any interested parties. Only data that were collected as match or data from sites outside the EPA MRG reach are housed on the web, as per the restrictions on posting EPA-funded data from an educational grant.

4) There will be three BEMP-hosted data and analyses sharing events each year, one in February, one in June, and one in the fall. BEMP hosted six data and analyses sharing events over the course of this grant.

5) There will be a BEMP Student Congress in April each year at which students will present data and interpretation to other schools and the community. BEMP Student Congresses were held each April during which students presented data and their interpretation to students and teachers from multiple schools and to the community. The representatives of local media were also present at some Congresses.

6) There will be a community event at Valle de Oro at the end of the project to share data with the public. BEMP staff presented at the Valle de Oro Birthday Celebration on September 24 from 10:00-3:00. BEMP hands-on monitoring experiences were provided and water quality issues were discussed with roughly 40 community members (students and adults). Data from BEMP sites were shared.

7) There will be a special "data jam" for students to present the data in creative ways at the end of the project. Eight high school students from Nex+Gen Academy presented their water quality data to 60 students from Jefferson Middle School in round-robin presentations. The fun style of student-led presentations and outreach to more students met the same intent as a "data jam", although we did not call it a "data jam" at the time. Students were also given the opportunity to do their own hands-on water quality monitoring.

Outcomes

In the following section, predicted outcomes are in blue text, actual accomplishments are in black text. Outcomes were renumbered so as to be a continuation of the outputs, especially in regards to the following section on reasons why anticipated outputs/outcomes were not met.

8) Baseline data for health of the Rio Grande, groundwater and ditches will be established and widely communicated allowing for conversations about future actions and/or remediation. Baseline data that indicate the health of the Rio Grande, groundwater, and ditches have been established. Only data not funded by EPA will be communicated, although student presentations have provided a starting point for conversations about future actions.

9) Partnerships between pueblos, agencies, schools, and BEMP will be strengthened and increased communication may lead to a broadly shared plan of action for the watershed. Partnerships between BEMP and pueblos, federal and state agencies, and schools are stronger than ever. Even though data from the EPA-funded water quality monitoring cannot be shared, BEMP has continued to work on collaborations and meeting the needs of both data users and educators. Current and future issues/challenges that affect watershed health and management are frequently discussed with BEMP staff in classrooms, meetings, conferences, and festivals. A broadly shared plan of action is still desirable, but still in the future, especially in a changing political climate.

10) Improved water quality through increased data and collaborative meetings between stakeholders. As with the previous outcome, improved water quality is desired, but not a current outcome. Increased data collections have been met, and sharing has been requested, but only data from the two-four match sites will be shared. These data will eventually be used to inform stakeholders about the state of water quality in the Middle Rio Grande.

11) Students at SODA and another monthly monitoring school will become competent with field water quality sampling. This will increase students' comfort level in, and sense of stewardship of the Rio Grande and bosque. Students at School of Dreams Academy (SODA) were unable to commit to water quality sampling in addition to their monthly monitoring schedule, but they did learn to monitor water quality field parameters and participated in fish captures to identify species. They learned to monitor streamflow, count and identify fish species and measure water temperature. BEMP did involve three other schools in water quality sampling. Middle and high school students from Nex+Gen High School, Rio Rancho High School, and The International School at Mesa del Sol were actively involved in the water quality data collections. Most of the students involved became very competent at the field protocols and later made presentations of the data they collected. Amy Biehl High School students participated in a field trip to Bio Park to test water quality and sample macroinvertebrates – demonstrating how to

collect water quality and the importance of water quality and stewardship. Being in the river for sampling and spending more time in the bosque/forest strengthened the students' comfort with, commitment to, and sense of stewardship for the bosque and river.

12) Increased hands-on education about the watershed and impacts to water quality for all monthly monitoring students. Watershed health and impacts to water quality were discussed during monthly monitoring trips as well as in classrooms. Hands-on education was absolutely increased throughout this grant. Water quality issues, impacts and importance were discussed with students from multiple schools at multiple monthly monitoring events throughout the grant period. In addition, 30 University of New Mexico students and three summer high school interns were involved in hands-on monitoring of water quality data.

13) Two college students and/or young professionals will gain competence in field water quality sampling, public outreach, and will contribute to the health of their watershed. Sean and Iman (college students) became proficient at water sampling. Sean presented water quality at 61st Annual New Mexico Water Conference (WRRI). Both college students talked with students and teachers during BEMP monthly monitoring about water quality and importance of upper-watershed health. Sean presented at Rio Rancho Cyber Academy to talk about where their water comes from (led a tour of the Drinking Water Diversion Dam and pumping station), water quality, and importance of urban citizens sharing water with agriculture. In addition, Kinsey, a third college student, a recently graduated senior from Rio Rancho High School, did a summer internship with BEMP (the summer before attending Brandeis College) focusing on water quality collections and presentations.

Section 2. Reasons why anticipated outputs/outcomes were not met (numbers correspond to the above section for those anticipated outputs not met)

1) The number of sampling sites funded by this grant remained consistent, as well as the number of samples collected (663 samples were actually collected, 658 samples were anticipated), but the number of match sites were reduced. The decision to drop match sites was made because the monitoring time involved and the number of staff needed to collect the data were underestimated in the original proposal. BEMP Science Coordinator Jennifer Schuetz, Ecologists Kim Fike and Rowan Converse, and Educator Kelly Steinberg were trained by the NM Environment Department (NMED) Surface Water Quality Monitoring Bureau Monitoring Team Lead Scott Murray and NMED Quality Assurance Officer Jodey Kougioulis in collecting and handling water quality samples and assessing instrument accuracy. Following NMED protocols while also involving students required more staff time, and this allowed us to still meet the match requirement while maintaining excellent education and quality controlled data collection. Our match was met with staff time and monitoring of only two sites within the designated boundaries of the EPA Urban Waters Middle Rio Grande reach. We did not capture the two storm events, as our match (mostly donated staff time and lab fees) was much higher than anticipated; however, our total number of samples collected was higher than the anticipated number of water samples collected.

3) Initially, the grant was submitted without a previously accepted QAPP and QMP. The proposal stated that we would work on a QAPP and submit it after funding was received. This course of action was discussed and supported in phone conversations between EPA personnel and BEMP staff. When the QAPP was submitted, after some of the sampling had already been accomplished, we were told that we could not retroactively apply a QAPP and QMP and to keep this grant as an educational grant. Therefore, some of our stated outputs and outcomes are not allowable as an educational grantee, including putting EPA-funded data on our website or making the data available to resource managers. However, we will

post the data from the match sites and from the sites outside the designated boundaries of this grant, and this will help us meet those stated outputs and outcomes.

Table 1. Timeline of projected milestones (many of which are also the anticipated outputs for this grant) and the corresponding realized accomplishments.

Year	*Month*	*Projected Milestone/Outputs*	*Accomplishment*
2014	September	Work with partners to refine and agree on QAPP. Collect water quality data at nine sites (field parameters, nutrients, *E. coli*, PCBs, and pesticides); PCPPs will be collected at four sites (If there is not time to start with the August collection, then the project will end with the August collection in 2016)	Worked with partners in NMED and Ciudad SWCD to refine QAPP. Grant awarded late, so first set of complete water quality sampling was done in November.
	October	BEMP field tour with Rio Grande managers and concerned citizens (Sept. 29) that will explain the purpose of the grant, how we will carry out the water quality monitoring, and when and how we will be sharing results. Location of field tour will relate to sampling schedule.	Field tour held at Valle De Oro (VDO) and State Land Office (SLO) BEMP sites on Oct. 29. Water quality issues, watershed health, and riparian response to anthropomorphic drivers were emphasized. 2 BEMP staff attended the 2014 Quality Assurance Conference held in New Mexico and led by the EPA Region 6 Team
	November	Monthly monitoring schools will be alerted to possibility of conducting additional water quality monitoring and one school (in addition to School of Dreams Academy - SODA) will be selected to participate. Interns will be selected and Field Technicians will be hired. Collect water quality data at nine sites.	Three schools accepted invitation to involve students in water quality sampling. 11 sites monitored for field parameters; 9 monitored for *E. coli*, pesticides, PCBs, and anions/nutrients (samples for anions for two sites were lost in the move from one lab to new lab); 4 sites monitored for PPCPs (meeting September commitment)
2015	February	Crawford Symposium featuring research of scientists and students. Keynote speaker for event will relate to water quality in the Rio Grande.	Crawford Symposium held at UNM, featuring scientists and students. Keynote speaker was Laura McCarthy from The Nature Conservancy; she spoke about the Rio Grande and its watershed, the importance of upper watershed health on water quality and the Rio Grande Water Fund.
	April	BEMP Student Congresses. Students involved in the water quality collection will present initial findings (both from their field parameter and nutrient monitoring, as well as BEMP-collected *E. coli*, PCB, and pesticide data).	BEMP Student Congress held on April 24 for 7-12th grades and April 25 for 4-6th grades. 346 students and 60 adults attended both events combined. Water quality stations were led by university students and high school students talked about water quality data.
	April/May	Water quality will be sampled at nine sites (before snowmelt runoff)	Water quality samples collected at 9 sites plus 3 match sites in late March, before snowmelt runoff
	June	BEMP Educator and BEMP Data User Focus Groups. Results of monitoring thus far will be shared.	Data User Focus Group met on June 19; BEMP data were discussed, except for water quality data due to educational status of grant. Educator Focus Group: teacher trainings/orientation held with individual new teachers as they came on board.

	June/ August	Collect water quality data at nine sites (field parameters, nutrients, *E. coli*, PCBs, and pesticides); PCPPs will be collected at four sites	Water quality samples collected at 9 sites plus 3 match sites in early July; PPCPs collected at 4 sites.
	October	BEMP field tour. Results of one year of water quality monitoring will be shared with river managers and concerned citizens.	BEMP Fall Field Tour held Oct. 16, featuring the BEMP sites above and below the San Juan-Chama Drinking Water Project Diversion Dam. Talks centered on water quality, impacts of drought, and climate change.
	November	Water quality will be sampled at nine sites	Water quality samples collected at 9 sites plus 3 match sites in November; PPCPs collected at 4 sites.
2016	February	Crawford Symposium featuring research of scientists and students. Keynote speaker for event will relate to first year of water quality sampling and analysis.	Crawford Symposium held at UNM on March 1, featuring scientists and students. Keynote speaker was Laura Pascus. Focus was on how the bosque, Middle Rio Grande and its watershed can be better understood through scientific research conducted by students and professionals. Middle and high school students from Rio Rancho High School and The International School at Mesa del Sol presented water quality data.
	March	Monthly Monitoring schools will receive a classroom visit from a BEMP educator to learn about the water quality data and receive an assignment to develop a way to interpret it and share it with other students at the BEMP Congresses, and possibly with their parents at school Math & Science nights.	BEMP educators met with schools on multiple occasions (not just in March) to help students state hypotheses, graph, run statistics and interpret water quality data collected. BEMP educators also help students prepare PowerPoint presentations and posters.
	April	BEMP Student Congresses. Students will share their interpretation of water quality data with each other, based on "data jams" model of the Jornada Basin Long Term Ecological Research site.	Nex+Gen Academy high school seniors and juniors presented their water quality findings and taught water quality methodology, results and why water quality monitoring is important to 7th grade students from Jefferson Middle School at the Valle de Oro National Wildlife Refuge (round-robin presentation style): 6 presentations
	April/May	Water quality will be sampled at nine sites (before snowmelt runoff)	Water quality samples collected at 9 sites plus 3 match sites in April (before snowmelt runoff)
	June	Public event at Valle de Oro to share data analyses.	Valle de Oro Birthday Celebration September 24, BEMP staff presented on BEMP protocols and collecting groundwater data.
	June	BEMP Educator and BEMP Data User Focus Groups. Results of monitoring thus far will be shared.	BEMP Educator Training was held on June 10, and focused on BEMP protocols, data, and analyses and how to use each of these in the classroom. BEMP Data User Focus Group was combined with Fall Field Tour and was held on Oct. 14; need for water quality data was discussed, but water quality data were not presented due to educational status of grant.

	June/ August	If sampling does not start in August 2014, final collection of water quality data at nine sites (field parameters, nutrients, *E. coli*, PCBs, and pesticides); PCPPs will be collected at four sites	Water quality samples collected at 9 sites plus 3 match sites in August; PPCPs collected at 4 sites.
	July	(requirement of grant, not originally stated in milestones)	Final presentation given at EPA Urban Waters Meeting to all Urban Waters partners
	November	Final report write up posted to BEMP website	EPA granted extension through December. Report finished and submitted. Not posted online due to water quality data. A total of 663 water samples were collected in the MRG through the life of this grant.

Section 3. Other pertinent information (analysis and explanation of cost overruns or high unit cost)

The biggest shift in our anticipated outputs and our actual outputs was the lower number of match sites sampled during the life of this grant. This was due, as mentioned above, to the underestimation of the amount of time that would be involved in collections (personnel costs). BEMP had done water quality sampling in the past, but never multiple types of water sampling at the same time, and not at so many sites for time-sensitive samples like *E. coli* (which have to be delivered to the lab within eight hours of collection). In addition, we sampled five groundwater wells at each BEMP site, the water in the ditch and the water in the river. The estimated 16 hours (as stated in the original proposal) was actually 65 hours/person for the first water sampling collection in November 2014. This included prep time, time for ordering the sample vials, field time, deliveries, packing and mailing time, and clean up. Dropping sites and finding a tighter routine allowed us to drop this down to 45-55 hours per sampling collection, which was still more than double to triple the amount of time that we were billing. The final collection took 45 hours, which did not include sampling the sites outside the parameters of this grant. Including those two sites brings the per person collection time to 53 hours. BEMP did not ask for a budget increase, but instead paid for some of the core seven sites through match rather than through EPA funding.

Section 4. Project as a success story

<u>Success in data collection and quality control</u>

BEMP has a well-established system for quality control of field work, lab work, and data entry. Our thorough protocol documents outline the steps for collecting data accurately, and keep the process standardized across sites and sampling periods. These documents are available online at BEMP.org/research-guides-protocols, for anyone who wants to use our data or replicate our procedures. This transparency, as well as BEMP's position as a non-advocacy group, puts our organization in a valuable place for data users and land managers. Our water quality data have been requested by several different agencies, including the New Mexico Environment Department, the University of New Mexico, Bernalillo County, and the Albuquerque Metropolitan Arroyo Flood Control Authority. BEMP's willingness to train using state and federal agency protocols, consistency in data collection and QA/QC, and our non-advocacy position have been instrumental in promoting strong partnerships with agencies and allowing them to rely on BEMP collecting valid data. The multiple requests from various agencies for the data collected under the EPA Urban Waters grant has demonstrated the need for water quality data in this region, but it also demonstrates that BEMP

provides a successful model for non-profit organizations that are interested in forming partnerships that do not rely on advocacy.

Educational outreach success

The students who worked hands-on with BEMP staff members through educational outreach facilitated by the EPA Urban Waters Grant benefitted substantially from our outreach efforts. We worked with roughly 200 students across 7 middle and high schools and universities spanning a diverse array of the Albuquerque community as well as communities outside of Albuquerque. These are students that were involved in water quality monitoring or experiences and do not include students involved in BEMP monthly monitoring. Citizen science is at the heart of BEMP's mission statement, and recently BEMP was recognized as a success story by BioScience (Baker, 2016). Our water quality outreach is no exception.

One measure of success is the experience of eight Nex+Gen Academy students who worked with BEMP to collect water quality data at the Valle de Oro National Wildlife Refuge in southern Albuquerque. After BEMP presented water quality data and procedures to all of the seniors at the Academy, two teams of four students each chose to work with BEMP to pursue further water quality monitoring. The first of the four sampling events was spent with BEMP staff thoroughly and slowly explaining and demonstrating monitoring procedures to the students. Each collection included the monitoring of six groundwater wells, one ditch site, and one river site. By the end of the fourth field excursion, the students were in charge of collecting the data according to proper procedures while BEMP staff provided oversight and ensured protocols were followed. This approach allowed the students to learn all the procedures, and empowered them to understand and trust the data they collected. Towards the end of the project, the students were beaming about having picked "the best project," and one of our teams even received the 'Senior Best Team' award. These students went on to analyze the data and then present their findings to 7th graders at Jefferson Middle School and to their fellow schoolmates at Nex+Gen. They began with almost no understanding of water quality or chemistry terminology, and finished the project explaining the definitions of the concepts along with passionate commentary on why the audience members should care about water quality. Overall, these students were inspired by their work, and empowered by our trust in them to collect, analyze, and present the data themselves. The water quality datasheet used by Nex+Gen Academy students for collecting data has been attached as a separate document.

The Rio Rancho High School students also were inspired by the hands-on experience through BEMP. After being in the field with BEMP staff members during a sampling week, the students identified an aspect of water quality that interested them and analyzed the data with the mentorship of BEMP staff. They presented to peers at their school, entered their work in their local science fair, presented to a room full of around 175 people—both peers and professionals—at BEMP's Crawford Symposium, and finally presented to New Mexico Senator Tom Udall in May 2016.

These two stories exemplify the success of BEMP's outreach efforts under the EPA Urban Waters grant. We take the process of exposing the students to hands-on data collection a step farther, by empowering them as scientists, demonstrating our trust in them to collect data on their own, analyze those data, and present it to their peers as well as professionals in the field of water quality and beyond.

Areas for improvement

To ensure that the data were collected on time and were collected accurately, our educational outreach numbers were limited during our water quality sampling weeks. While we still made sure to always have University of New Mexico undergraduate or graduate interns, high school students, or students on the BEMP staff team to help with data collection and sampling, we were limited in our capacity to involve a

large number of K-12 students. Instead, our educational outreach was largely done during separate field trips and events. We could have improved upon this aspect of our grant obligation. Primarily, committing to collecting data at a smaller number of sites would have increased the amount of time spent at each site. This would allow for a group of students to meet us at the site and learn the field procedures and get hands-on experience. Alternatively, students could be in the field while BEMP staff members are collecting water quality data, and a parallel educational experience could be led by another BEMP educator. For example, while BEMP data collectors are in the river collecting PPCP samples, the educator on the bank of the river could teach the students the implications of any pharmaceuticals and personal care products found in the water.

Water Quality Monitoring

Sampling Methods

BEMP staff and students gathered water quality data throughout a four-day sampling period starting from the southernmost site and progressing northward (see figure 1 for site locations and names). Throughout these collections, high school and college students assisted with testing surface water and groundwater for field parameters (temperature, pH, dissolved oxygen (DO), turbidity, conductivity and specific conductance) and anions (nitrate, phosphate, chloride, bromide, nitrate, fluoride, and sulfate).

Photo of Rio Grande during August 2016 water quality sampling at the Sevilleta BEMP site (outside the boundaries of this grant).

Additional testing for *E.coli*, fecal coliform, pesticides and polychlorinated biphenyl (PCBs) was performed on ditch and river samples (and a few groundwater wells). Four of the river sampling sites were tested for pharmaceuticals and personal care products (PPCPs) using a single grab sampling technique performed by BEMP staff members four times through the life of the grant. *E.coli* analyses were performed by the NM State Labs; anions were analyzed through the UNM Department of Chemistry; and pesticides, PCBs, and PPCPs through Eurofins Scientific Laboratories. Protocols used by BEMP for field parameters, anions, and *E. coli* are available on the BEMP website at http://bemp.org/research-guides-protocols/ under "WaterQuality"; we have included these protocols as a separate attachment as well. Our QA/QC procedures are not online, but are available on request.

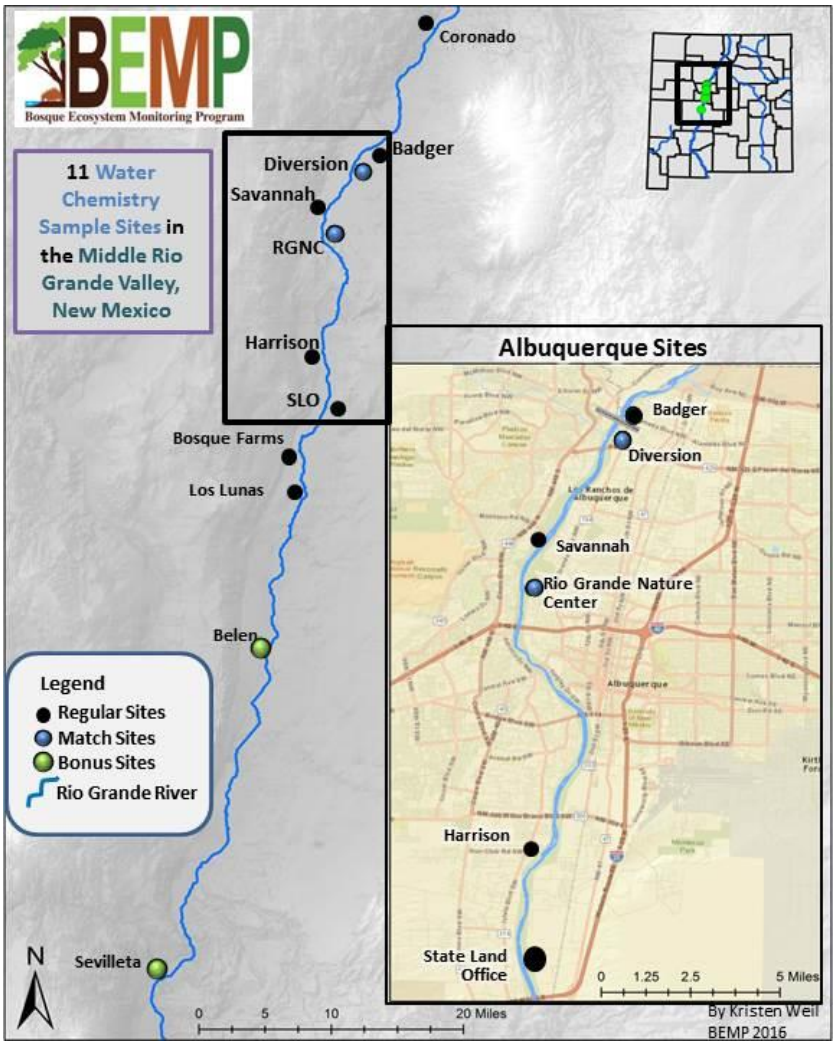


Figure 1: BEMP water quality sampling sites. Black dots indicate EPA-funded sites, blue indicate match sites, and green indicates bonus sites outside EPA Urban Waters MRG boundaries.

Monitoring Results

Large variation within the field parameters occur between seasons and throughout the years. Levels of *E. coli* in the river and ditches increase as the water travels downstream. Large increases in PPCPs occur south of Albuquerque, with detected compounds including artificial sweeteners, pesticides (e.g., DEET), flame retardants, antibiotics and more. There were no pesticides or PCBs detected in any of the seven sites during the six sampling periods across the two-years for this specific analysis. The pesticides being tested for in this analysis were organochlorine pesticides (which do not include DEET), and none of this type of pesticide were detected. The lab analyses for PCBs and pesticides had a detection limit of .1 to .01 ug/L for most of these compounds; a ng/L detection limit would have been more appropriate, as the chronic level for aquatic life (as set by the water quality standards of NMED) is 0.014 ug/L (NMAC 2000). Continual monitoring of our river system will allow us to better understand human influences on water quality and how it may impact downstream users and the adjacent riparian ecosystem.

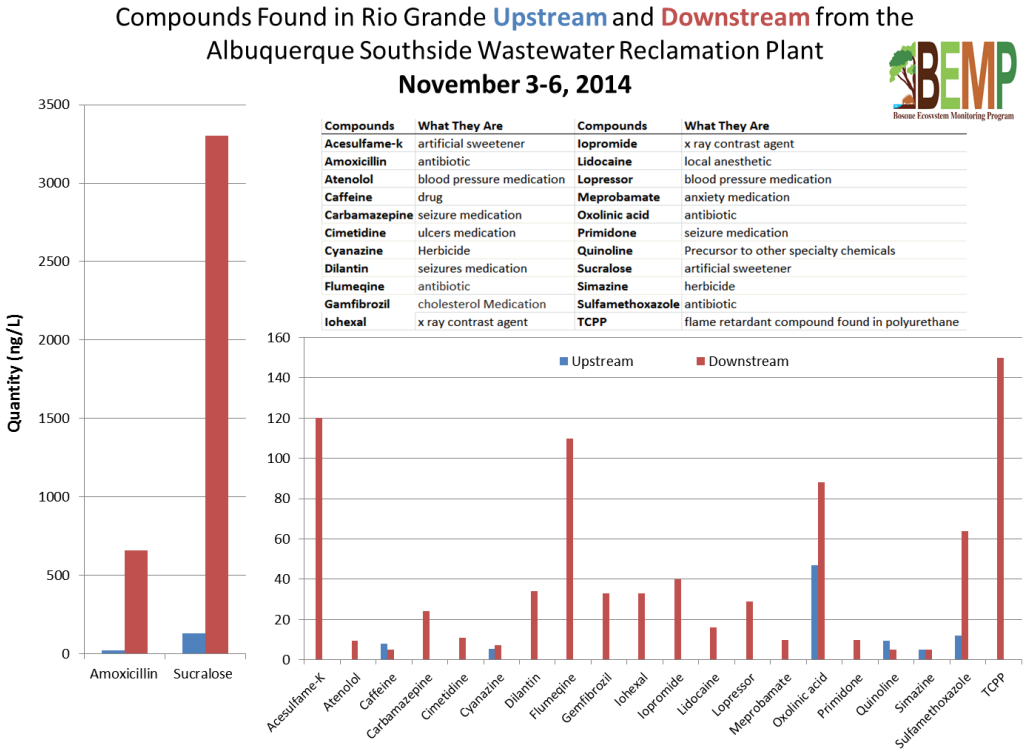
Data from each type of sampling have been presented below. The complete dataset is attached in excel format. Photos were taken at each river site (facing upstream) and each ditch site (facing upstream) for each sampling date; these photos are available on request. (Samples below)

Ditch at the Los Lunas BEMP site, facing north/upstream, on 4 April 2016.

River at State Land Office (SLO) BEMP site, facing north/upstream, on 5 April 2016.

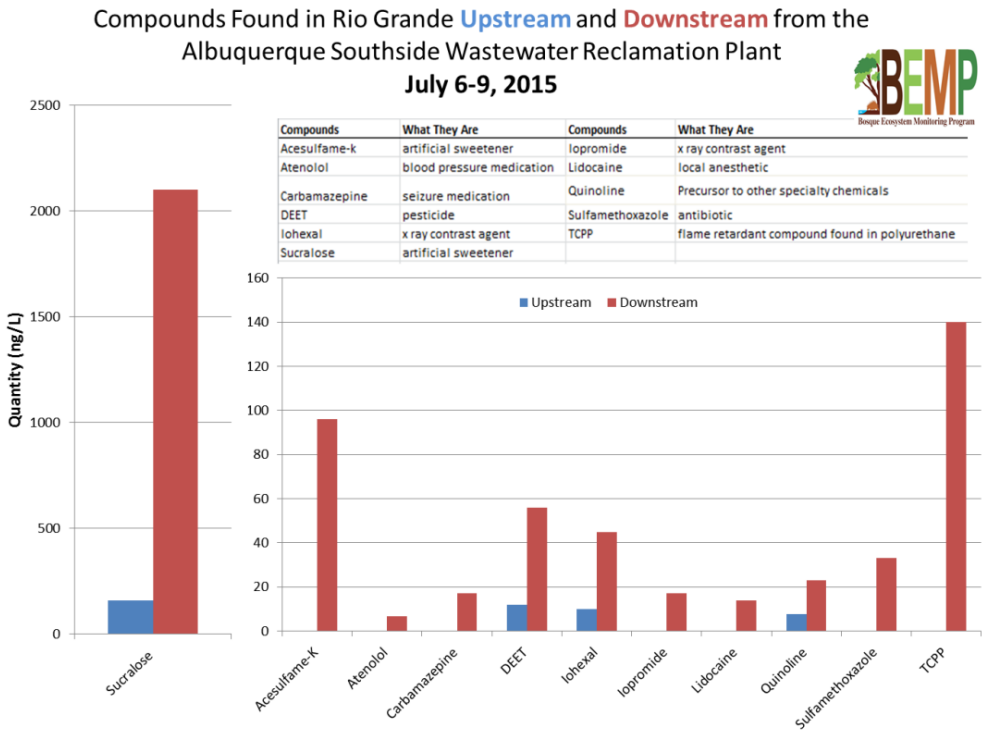
Sampling for Pharmaceuticals and Personal Care Products (PPCPs)

The majority of the 33 compounds detected from all of the samples occurred periodically and with varying quantities throughout the collection periods. Artificial sweeteners such as sucralose and antibiotic medications were more consistently detected and were detected in greater quantities than many other compounds. With a few exceptions, the PPCPs occurred in higher concentrations downstream from Albuquerque's Southside Wastewater Reclamation Plant; many of the detected compounds were not found upstream from the Reclamation Plant in any detectable quantity. Results from individual collection dates are shown below (Figures 2-5).



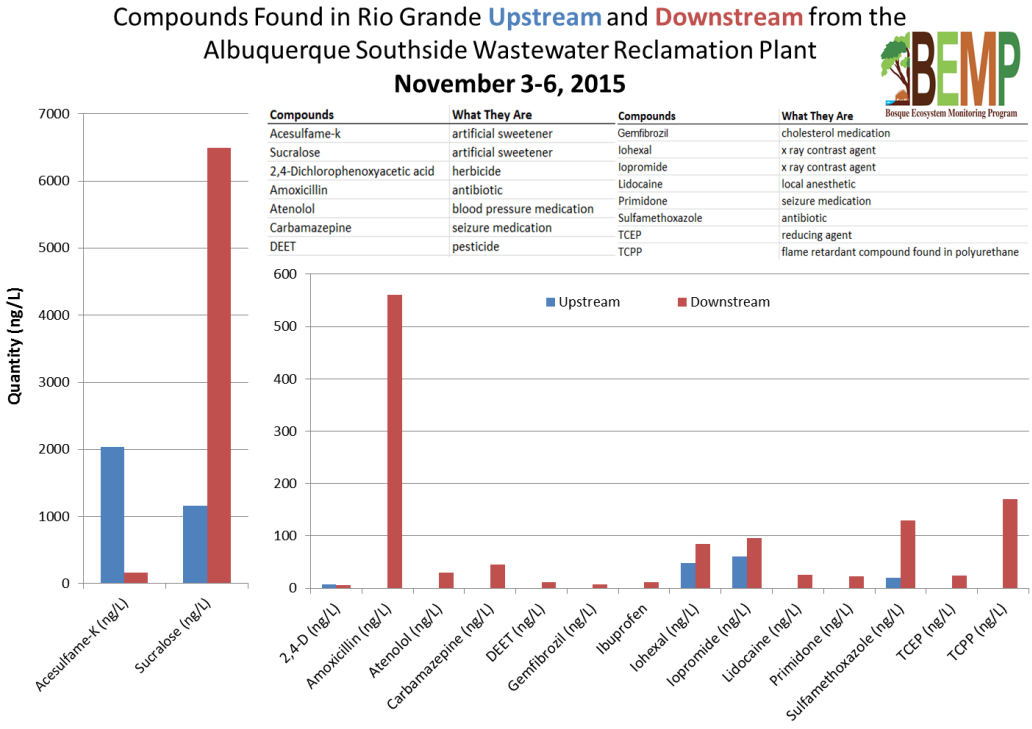
Compounds	What They Are	Compounds	What They Are
Acesulfame-k	artificial sweetener	**Iopromide**	x ray contrast agent
Amoxicillin	antibiotic	**Lidocaine**	local anesthetic
Atenolol	blood pressure medication	**Lopressor**	blood pressure medication
Caffeine	drug	**Meprobamate**	anxiety medication
Carbamazepine	seizure medication	**Oxolinic acid**	antibiotic
Cimetidine	ulcers medication	**Primidone**	seizure medication
Cyanazine	Herbicide	**Quinoline**	Precursor to other specialty chemicals
Dilantin	seizures medication	**Sucralose**	artificial sweetener
Flumeqine	antibiotic	**Simazine**	herbicide
Gamfibrozil	cholesterol Medication	**Sulfamethoxazole**	antibiotic
Iohexal	x ray contrast agent	**TCPP**	flame retardant compound found in polyurethane

Figure 2: Pharmesutical and personal care products testing results from four river collection samples taken from November 3-6, 2014.



Compounds	What They Are	Compounds	What They Are
Acesulfame-k	artificial sweetener	Iopromide	x ray contrast agent
Atenolol	blood pressure medication	Lidocaine	local anesthetic
Carbamazepine	seizure medication	Quinoline	Precursor to other specialty chemicals
DEET	pesticide	Sulfamethoxazole	antibiotic
Iohexal	x ray contrast agent	TCPP	flame retardant compound found in polyurethane
Sucralose	artificial sweetener		

Figure 3: Pharmesutical and personal care products testing results from four river collection samples taken from July 6-9, 2015.



Compounds	What They Are	Compounds	What They Are
Acesulfame-k	artificial sweetener	Gemfibrozil	cholesterol medication
Sucralose	artificial sweetener	Iohexal	x ray contrast agent
2,4-Dichlorophenoxyacetic acid	herbicide	Iopromide	x ray contrast agent
Amoxicillin	antibiotic	Lidocaine	local anesthetic
Atenolol	blood pressure medication	Primidone	seizure medication
Carbamazepine	seizure medication	Sulfamethoxazole	antibiotic
DEET	pesticide	TCEP	reducing agent
		TCPP	flame retardant compound found in polyurethane

Figure 4: Pharmesutical and personal care products testing results from four river collection samples taken from November 3-6, 2015.

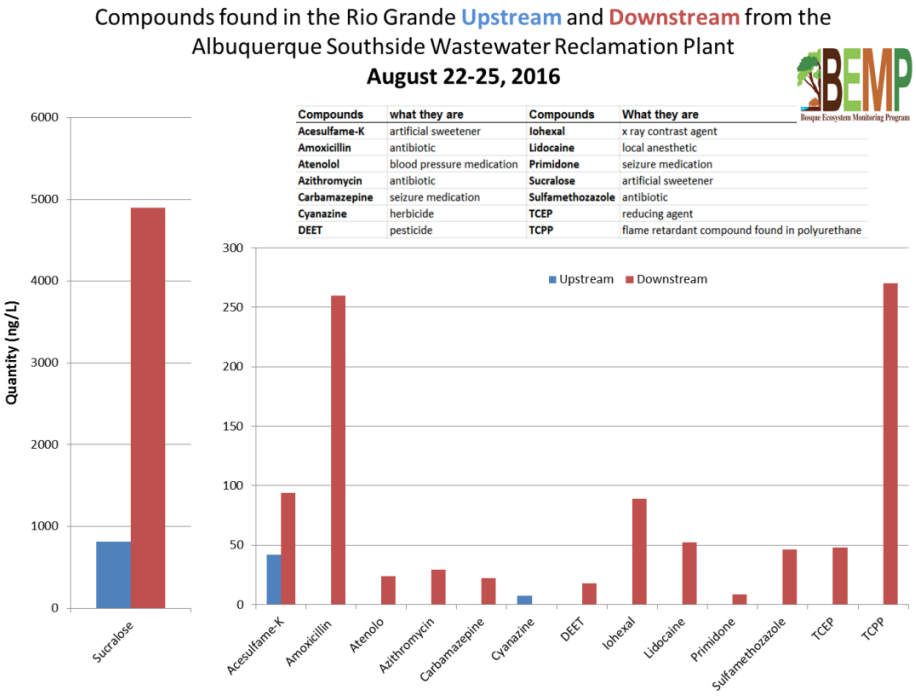


Figure 5: Pharmesutical and personal care products testing results from four river collection samples taken from August 22 - 25, 2016.

Sampling for E. Coli

Levels of *E. coli* in the river were typically higher than in the paralleling ditches than in the river (Figures 6-9). In July 2016 there were exceptionally high levels within the ditches at the State Land Office (SLO) site (note the log scale on the y-axis for these graphs) (Figure 8). No consistent spatial trends occurred, as the site with the maximum and minimum concentrations shifted across the sites and throughout time. Summer months revealed the highest concentrations of *E. coli*, well above the 410 cfu/100 mL standard set by the New Mexico Environment Department (NMAC 2000).

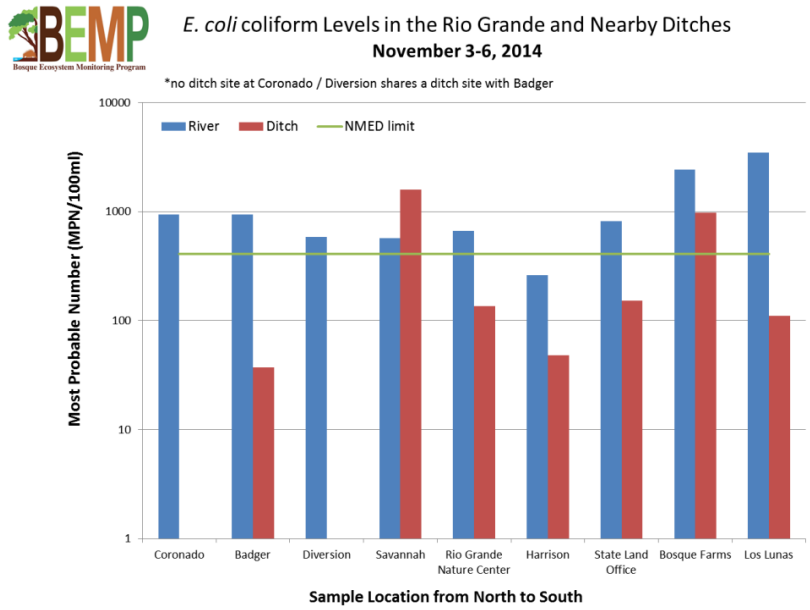


Figure 6: *E.coli* coliform levels from the river and nearby ditches from November 3-6, 2014.

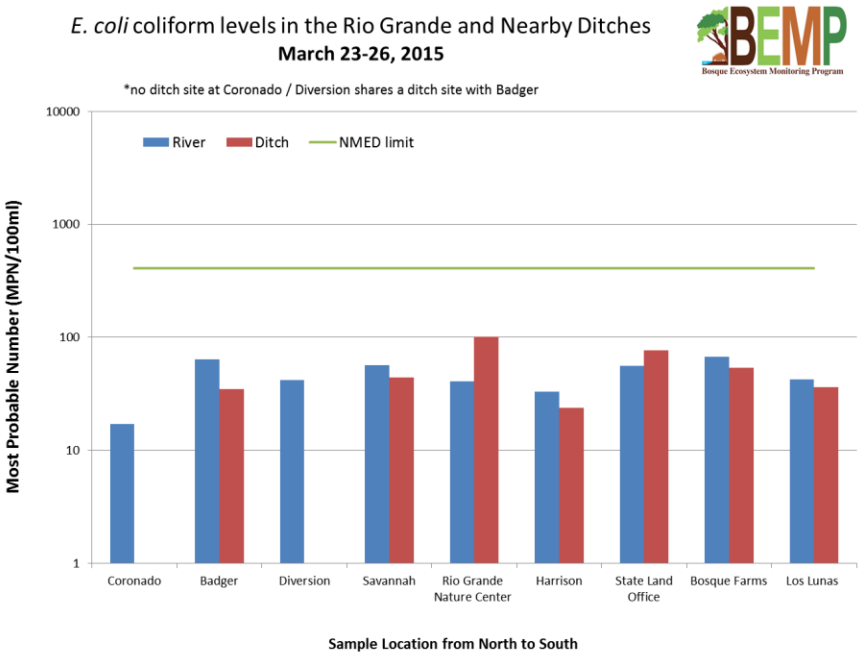


Figure 7: *E.coli* coliform levels from the river and nearby ditches from March 23-26, 2015.

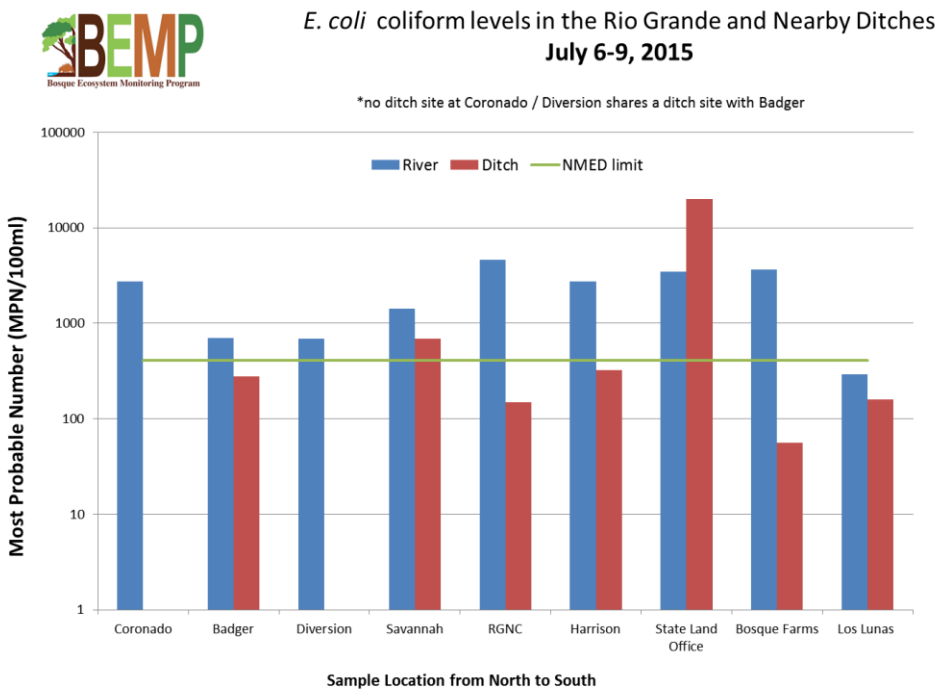


Figure 8: *E.coli* coliform levels from the river and nearby ditches from July 23-26, 2016.

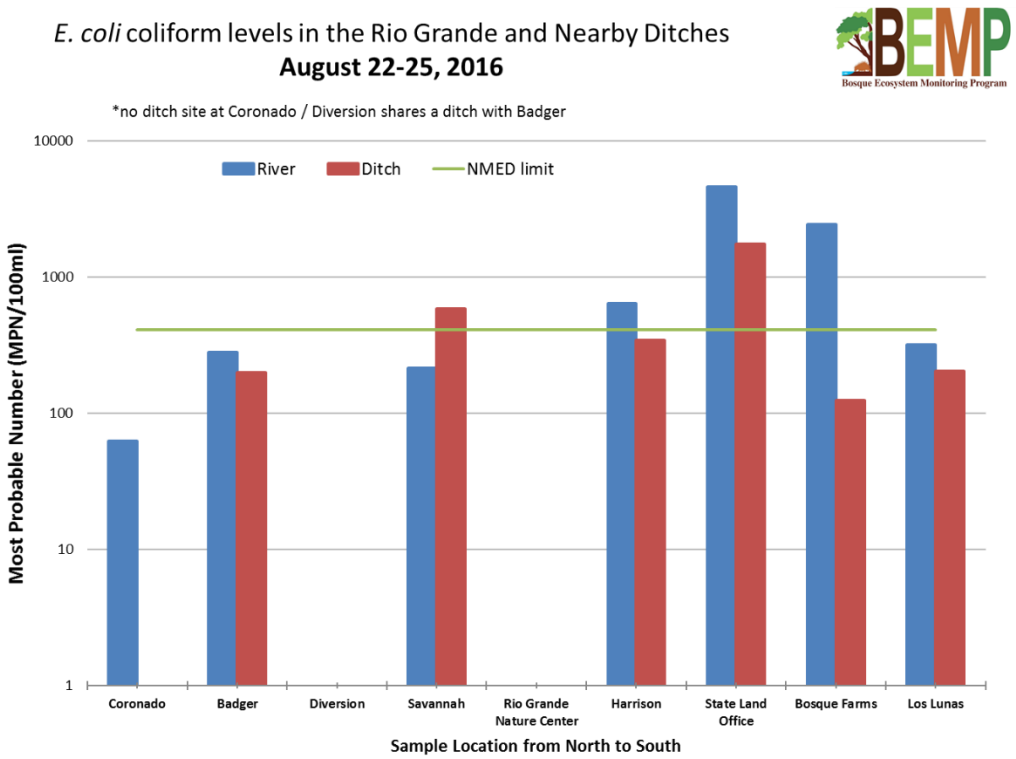


Figure 9: *E.coli* coliform levels from the river and nearby ditches from August 22-25, 2016.

Sampling for Nutrients

Anion samples were analyzed through the University of New Mexico Department of Chemistry for levels of chloride, bromide, nitrate, phosphate, sulfate, flouride, and nitrite. The graphs below show the concentrations of nitrate and phosphate over the sample period for the ditch, river, and groundwater wells at each site (Figure 10). Nitrate and phosphate levels did not show consistent spatial patterning. No phosphate was detected in the river at the Badger site for any of the sampling periods. There was a high degree of seasonal variability with nutrient peaks often occurring in November and a few in July. Greater concentrations of nitrate occurred within the river compared to the ditch and groundwater.

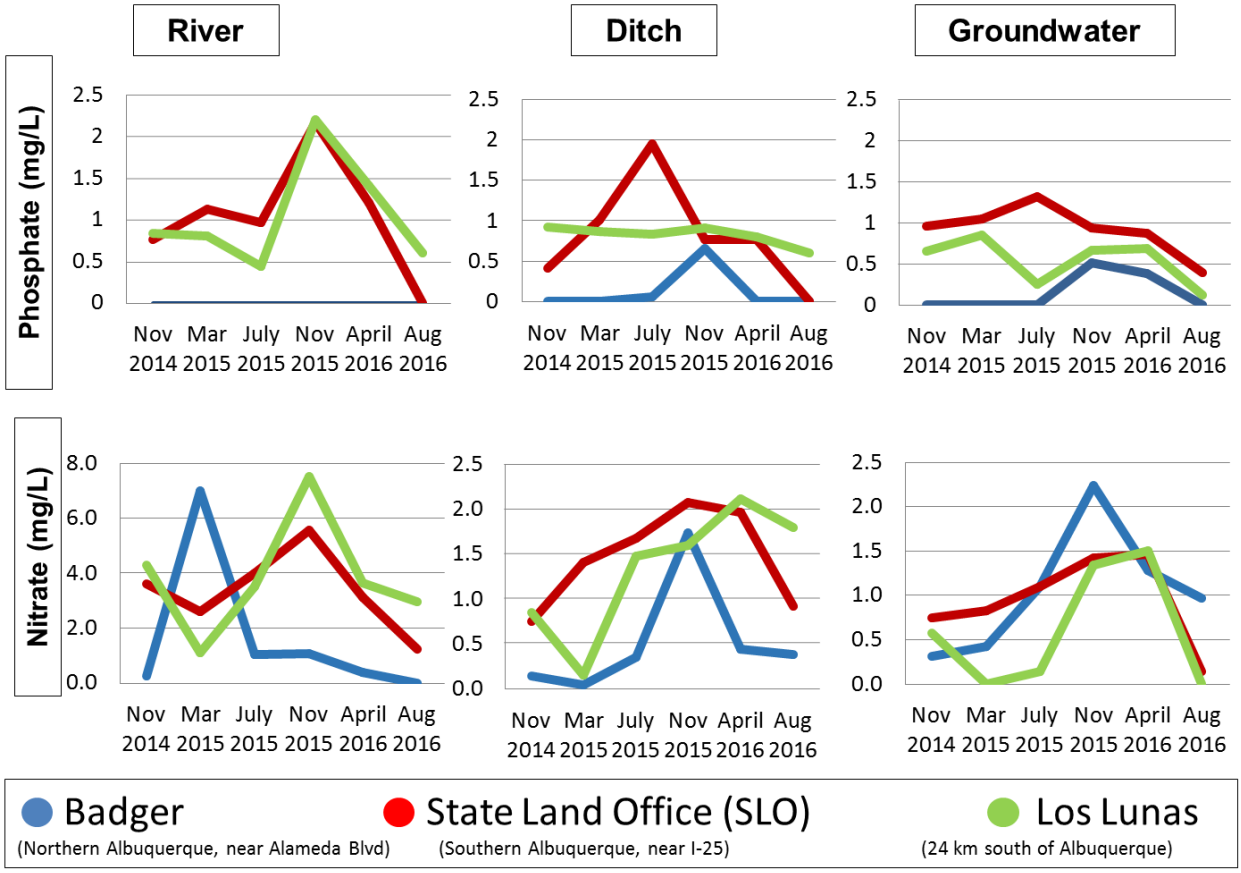


Figure 10: Nitrate and phosphate concentrations in the river, ditches and groundwater throughout the Urban Waters sampling period at three sites.

Field Parameters

At every sample location, measurements were taken in situ for dissolved oxygen (DO), pH, conductivity, specific conductance, turbidity, and temperature. The graphs below display DO (Figure 11) and pH (Figure 12) for one sample date (November 2015) for all sites from north to south. The pH of the river was consistently higher than the ditch and groundwater across all sites. Surface water pH (ditch and

river) gradually increases south of Albuquerque, while groundwater pH is high at Bosque Farms and then drops sharply at sites farther south. Dissolved oxygen in the ditch was variable, ranging from a minimum of 45% at the Badger site to 80% at the Sevilleta site. Dissolved oxygen in the river and groundwater were relatively consistent across all sites, besides a spike at the State Land Office (SLO) site in groundwater DO. River DO remained between 70 and 82%, while groundwater was below 10% at all sites besides SLO.

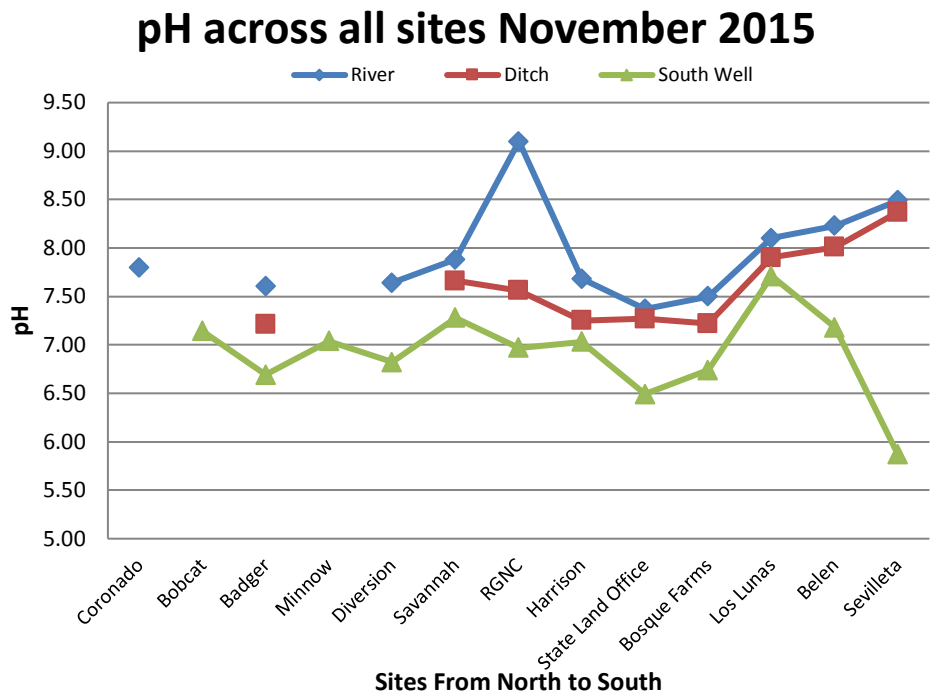


Figure 11: pH levels in the river, ditch, and south well at all sampled sites during the November 2015 collection week. Coronado is not a full BEMP site and only the river is sampled here. Only groundwater was sampled at two of the four match sites.

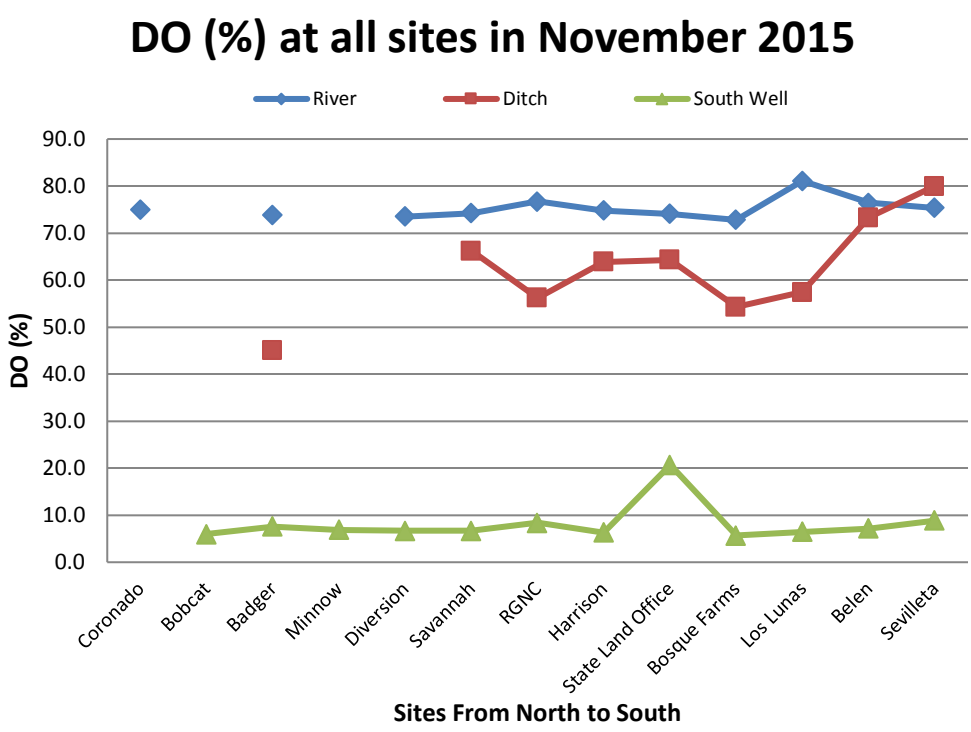


Figure 12: % Dissolved oxygen levels in the river, ditch, and south well at all sampled sites during the November 2015 collection week. Coronado is not a full BEMP site and only the river is sampled here. Only groundwater was sampled at two of the four match sites.

Discussion

Citizen science efforts between the years 2014-2016 contributed to the collection of these data with notable help of high school and university students. Our data suggest that the Albuquerque area has an impact on downstream water quality. The presence of introduced pharmaceuticals, personal care products, increased *E. coli* levels, and fluctuating nutrient availability in the river and ditches have potential harmful impacts on users downstream of Albuquerque. Additional monitoring is needed to understand the impacts these contaminants have on aquatic life, riparian health, agriculture, and humans. Education is crucial for community investment in understanding of the quality of this resource. Student involvement in data collection encourages continuing involvement in important work, innovations in water conservation, and stewardship of the Rio Grande and its riparian ecosystem.

<u>Summary of Educational Outreach</u>

Mentorship of Independent Research Projects

Whenever possible, high school and UNM students aided in collecting water quality data. BEMP staff taught the students the standardized data collection protocol, as well as the meanings and implications of all the parameters. Following data collection, and with the mentorship of BEMP staff members, these students went on to analyze the data they collected and present their findings to their community.

Three Rio Rancho High School students participated in the data collection process and subsequently developed a research project analyzing this information, which they presented in several different forums. Their goal was to use their findings to educate others including their classmates in an AP Environmental Science class about the health of the Rio Grande. They also shared their experience with members of the public, students, teachers, UNM professors, business professionals, and scientists at the 2016 Crawford Symposium. Their final display was a poster presentation in the New Mexico State Science Fair. These three Rio Rancho high school students wanted to inspire others to care about the quality of our precious river and encourage stewardship of our watershed. One of these students was later hired on with BEMP as a high school summer intern before she entered college.

BEMP staffers also aided in the development of two hydrology projects for eight high school students from Nex+Gen Academy. These students collected water quality data from six groundwater wells, the river, and the ditch at the Valle De Oro and State Land Office BEMP sites. After collecting this information once a week throughout the month of September, they analyzed their results, wrote up reports, and presented their findings to their classmates. They also presented to several classes from Jefferson Middle School at the Valle de Oro National Wildlife Refuge on how they collected the data, what they discovered, and why the information is relevant to them and the community.

Students from The International School at Mesa del Sol learned to monitor and present water quality data. Amy Biehl High School students participate in water quality testing, and a Bosque School 8th grader presented water quality data at the 2016 Desert Fishes Council Meeting.

Stormwater Science Outreach Education – Education Match (AMAFCA/SQT funded outreach)

In addition to mentoring high school independent projects, BEMP educators involved the community in water quality through a series of classroom visits, presentations, and community events funded by the Albuquerque Metropolitian Arroyo Flood Control Authority (AMAFCA) and the Stormwater Quality Team (SQT).

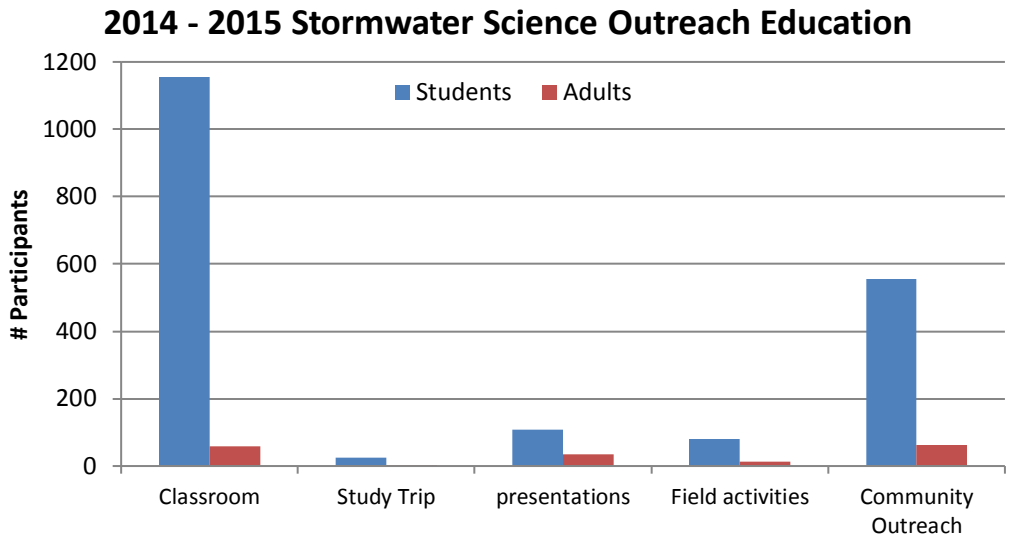


Figure 13: Number of students participating in Stormwater Science during the 2014-2015 school year.

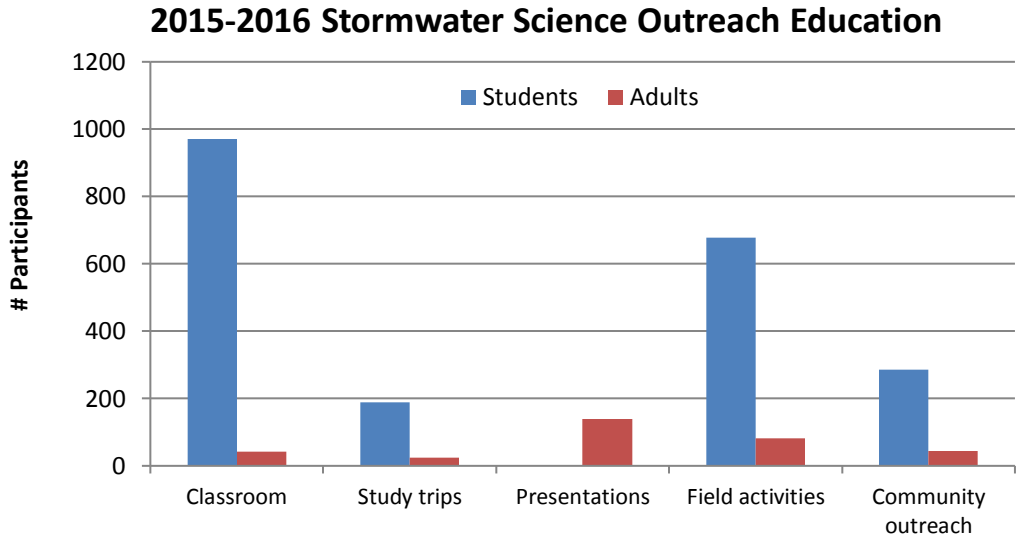


Figure 14: Number of students participating in Stormwater Science during the 2015-2016 school year.

References

Baker, B. 2016. Frontiers of Citizen Science. BioScience 66:921-927.

NMAC. 2000. Water Quality Control Commission. Environmental Protection Water Quality Standards for Interstate and Intrastate Surface Waters. New Mexico's Water Quality Standards. Title 20, Chapter 6 Part 4.

Encolosures

1. Field work datasheet for Nex+Gen Academy
2. All data collected (Excel file)
3. Water Quality Field Protocols